

EASTERLY GALES IN THE COLUMBIA RIVER GORGE DURING THE WINTER OF 1930-1931—SOME OF THEIR CAUSES AND EFFECTS

By DONALD C. CAMERON

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When Lewis and Clark explored down the Columbia River in 1805 they found a passageway from the great interior plains of comparative simplicity, with a few sections of rapids and narrows which required portage of their canoes and supplies. By a water-grade route they made their way through a mountain barrier which averages four to eight thousand feet in height, with peaks within 25 miles to the northward and southward rising to eleven and twelve thousand feet. The immediate slopes of this great gorge tower three and four thousand feet directly from the water's edge. While the river itself winds about to some extent, the general contour of the gorge is a gentle curve of 50 to 60 miles in length, the river running a little north of west from its eastern entrance, westward in the deepest section of the cut, and then slightly south of west into the open country of the north-south valley west of the Cascades.

The airplane finds here an easy passageway at normal flying levels through a mountain which at any other point north or south would require an ascent to at least four or five thousand feet to clear the lowest passes in safety. This latest mode of transportation has made possible and necessary the first intensive study of the meteorology of this important and extremely interesting stretch of territory.

Something should be said of the general climatic characteristics of the States of Oregon and Washington to bring out more clearly the marked contrasts which exist east and west of this narrow mountain chain. The coast range and western valley slopes are recipients of an abundant rainfall during the fall, winter, and spring months, averaging 40 to 80 inches a year, while immediately east of the mountains the rainfall averages less than 15 inches annually. Seasonal ranges in temperature west of the mountains are comparatively small, the winters being considerably warmer than is normal for the latitude and the summers cooler, while the interior sections have cold winters and warm summers.

Since there is a mountain barrier between these areas of marked climatic differences their proximity seems only natural, but when one considers a gigantic sea-level cut through this barrier the character of the weather which prevails within it can be better understood.

Geologically this gorge is unique and climatically also it must closely approach that distinction. From a place in the western portion where the annual rainfall amounts to 78½ inches at the river level, the precipitation falls off so markedly with progress eastward that at a point only 18 miles away it is only 34 inches, another 18 miles divides that figure in two, while still farther eastward we find a normal rainfall of only 8 inches.

In October, 1929, a series of four airway stations of the Weather Bureau was opened through the gorge. These are: Crown Point, 24 miles from Portland; Cascade Locks, 45 miles; Hood River, 65 miles; and The Dalles, about 90 miles. During the first four months, or the winter of 1929-30, these stations were not equipped with instruments, but in February, 1930 3-cup anemometers, wind vanes, thermometers, and barometers were supplied to each. January, 1930, had been a remarkable month in the gorge, easterly winds and gales were almost constant, temperatures low, snows deep, and the month, generally, one of the stormiest and coldest in many years.

During this period all the winds were estimated by the observers and it is now interesting to note that they never estimated current velocities to be over 50 miles an hour, while it is likely that winds of hurricane strength prevailed over the western portion. The strongest evidence of this is the fact that on the night of January 16-17, a Richfield beacon tower was bent and twisted to the ground by the force of the gale at Crown Point. Since the records of the winter 1930-31 have been compiled it is not difficult to realize that the total wind movement at Crown Point during that month would have approximated 25,000 miles, or an average velocity of 34 miles per hour.

Crown Point is one of the most exposed points along the entire western gorge. It juts out from the south wall at about 700 feet above the river and is very steep. The contour of the rocky formation is such that east and northeast winds are caught and forced upward over the summit, thereby accelerating the true velocity of the wind down the gorge and producing a gusty condition. The extent of this exaggerated condition is not definitely known since no records of wind velocity are available at any other point in the vicinity. At Cascade Locks, 20 miles eastward, the exposure was not entirely satisfactory and no continuous record was made. (NOTE.—The anemometer, recently removed to an excellent exposure on a rocky promontory in the center of the gorge, now indicates velocities equalling or exceeding those of Crown Point.)

The site at Crown Point was selected for a station because it commands a better view of a greater portion of the gorge than is obtainable from any other point and also because night and day service could be obtained at this place on call. The anemometer was exposed on a 12-foot support on the roof of a 1-story structure directly on the highway, so situated that the exposure eastward into the gorge is excellent. To the north the exposure is good, but due to the fact that the gorge runs east and west, cross winds are uncommon. Westward there is a slight obstruction in the form of some low trees across the highway, but the contour of the point in that direction is such as to ward off westerly winds which seldom exceed gentle to moderate velocities. Southeast, south, and southwest the exposure is unfavorable due to the hills which slope away from the crest of the point. Southwest winds occasionally reach moderate force during rainy periods when strong southerly winds prevail overhead and in the valleys to the west, but a wind velocity of 20 miles or more per hour has not been observed at Crown Point from any direction except east or northeast. On October 21, 1930, a single register for recording wind movement was installed and a continuous record commenced.

The only other records of continuous wind movement in the vicinity are those made at the regular Weather Bureau office in the customhouse in Portland, but the exposure is not satisfactory in all directions and does not represent a true picture of winds in the Portland area. The airport exposure is more satisfactory, there being no obstructions in the form of high buildings. It is low, however, when compared with surrounding hills and bluffs which are some distance from the instrument. Continuous wind movement was not available at this point but by making dial readings at midnight and using the daily total movement in connection with hourly current

velocities a very satisfactory record of total movement was obtained which represents more nearly the average conditions in the immediate Willamette Valley than does the customhouse record. Finally, dial readings were commenced on the 3-cup anemometer exposed on the summit of Council Crest in Portland. This exposure is without parallel in the Pacific Northwest, being 1,200 feet above the Willamette River and 88 feet above ground at the summit. Access to this point by automobile is fairly easy and dial readings were made every four or five days. The record obtained, however, is only for total wind movement but it represents a record of unobstructed flow of wind from all directions above the Portland area.

November, 1930, was the first complete month of record at these points and the following is a table of the wind data:

	Total	Average	Prevailing direction	Maximum velocity and direction
	<i>Miles</i>	<i>M. p. h.</i>		
Crown Point.....	12,580	17.5	NE.....	70 NE.
Council Crest.....	10,711	14.9	NE.....	
Portland Airport.....	4,496	6.2	SE.....	
Customhouse.....	3,451	4.8	SE.....	20 E.

From the above table it can be seen that Crown Point's total is 3.6 times that of the customhouse, 2.8 times that of the airport, but only 1.1 times that of Council Crest. During this month, the wind at Crown Point blew from the northeast 37 per cent of the time and 71 per cent of the total mileage, while at the customhouse the wind blew from the northeast only 4 per cent of the time and 3 per cent of the total mileage. Southeast was the prevailing direction in the city, the customhouse showing 31 per cent of the time and 30 per cent of the mileage from that direction, the airport 32 per cent of the time and 40 per cent of the mileage. This is the direction which occurs at these two exposures most of the time that strong northeast and east winds prevail at Crown Point. Another very interesting feature of the Crown Point wind during November is that the northeast wind averaged 33.2 miles per hour, the east wind 14.1, while no other direction gave over 6.5. The most remarkable period was from the 22d to the 26th, inclusive, when the wind blew from the northeast every hour of the 120 of the period and averaged 40.1 miles per hour! Equally remarkable is the record from the 21st to the 30th, inclusive, when the wind averaged 33.6 miles per hour and blew from the northeast or east every one of the 240 hours. At the customhouse during the former period the wind averaged 5.6 miles per hour, and during the 10-day period, 5.1 miles, the airport averaging slightly higher than the customhouse. These differences are surprising when one considers that there is no marked barrier in the way of hills between Crown Point and downtown Portland.

November 23d was the windiest day at Crown Point, there being a total movement of 1,278 miles that day, an average of 53.2 miles per hour. The writer had the pleasure of being at the Point during a portion of the day, but not during the time of the maximum wind, which occurred during the morning. Observing the clock closely and counting the buzzes on the wind indicator during some of the heavier gusts, an extreme velocity of 120 miles an hour was noted. The tops of several automobiles were wrecked as they rounded the Point; one

woman was thrown to the pavement by the gale and rolled against a stone abutment, suffering injuries which required hospital treatment.

The greatest total movements were recorded during December, 1930, but no unusually high maxima occurred. The following table is for December:

	Total	Average	Prevailing direction	Maximum velocity and direction
	<i>Miles</i>	<i>M. p. h.</i>		
Crown Point.....	17,135	23.0	NE.....	60 NE.
Council Crest.....	12,849	17.3	NE.....	
Portland Airport.....	5,520	7.4	SE.....	
Customhouse.....	4,071	5.5	E.....	20 E.

The total movement at Crown Point is unusually high, and an inspection of the total movements at regular Weather Bureau stations since the installation of 3-cup anemometers in January, 1928, reveals that it has been exceeded at only two, namely, by 4 miles at Buffalo during January, 1928, and at Tatoosh Island, Wash., during January, 1930, when a total of 17,947 miles was recorded. It is interesting to note that during December, 1930, the total movement at Tatoosh was only 12,718 miles, or 74 per cent of that at Crown Point. The wind movement at Crown Point during the month was over four times that recorded at the customhouse, over three times that at the airport, and 1.3 times that of Council Crest; 96 per cent of the Crown Point total movement was from the northeast or east, while it blew 71 per cent of the time from those directions. The northeast wind averaged 33.8 miles per hour, the east wind 15.6 miles per hour, but winds from other directions averaged only 6.5 miles per hour or less. In Portland the northeast wind as usual was negligible, while the southeast wind at the airport blew 54 per cent of the time, 68 per cent of the total mileage, and averaged 9.5 miles per hour. At the customhouse, east was the prevalent wind, blowing 34 per cent of the time, 49 per cent of the mileage, and averaging 7.7 miles per hour. The difference between the effects of these latter two exposures on east and southeast winds is almost wholly of topographical origin.

During January, 1931, large total movements were registered at the Point and at Council Crest, shown with the airport and customhouse figures in the following table:

	Total	Average	Prevailing direction	Maximum velocity and direction
	<i>Miles</i>	<i>M. p. h.</i>		
Crown Point.....	13,597	18.3	NE.....	54 NE.
Council Crest.....	12,530	16.8	SW.....	
Portland Aircraft.....	5,686	7.6	SE.....	
Customhouse.....	3,883	5.2	SE.....	30 S.

Comparisons during this month show approximately the same differences as during the two preceeding months, except that Council Crest's total approaches Crown Point's, due to the fact that southerly winds were more frequent over Portland than earlier in the winter.

February, 1931, is somewhat more striking in that the wind at Council Crest exceeds that at Crown Point for the first month since the study was commenced. The values for this month are shown in the table following.

	Total	Average	Prevailing direction	Maximum velocity and direction
	<i>Miles</i>	<i>M. p. h.</i>		
Crown Point.....	10,496	15.6	NE.....	54 NE.
Council Crest.....	10,585	15.8	NE.....	
Portland Airport.....	4,711	7.0	SE.....	
Customhouse.....	3,560	5.3	E.....	24 SW.

Due to the shortness of the month, total movements are proportionately lower, but Council Crest exceeds Crown Point in total movement by approximately 100 miles.

In the following table a brief summary of the four months, November, 1930–February, 1931, inclusive, is presented:

	Total	Average	Prevailing direction	Maximum velocity and direction
	<i>Miles</i>	<i>M. p. h.</i>		
Crown Point.....	53,908	18.7	NE.....	70 NE.
Council Crest.....	46,675	16.2	NE.....	
Portland Airport.....	20,413	7.0	SE.....	
Customhouse.....	14,995	5.2	SE.....	30 S.

From this it can be seen that Crown Point's total was approximately 3.6 times that at the customhouse, about 2.6 times that at the airport, but only 1.2 times that of Council Crest. However, when one considers that almost the entire mileage at Crown Point was from only two directions, viz., northeast and east, compared with free wind movement from all points at Council Crest, the difference is even more remarkable.

The causes of the easterly gales are interesting and as would be expected are due principally to the fact that during the winter time higher pressure prevails over the continent and lower pressure over the sea. The Cascades form a natural barrier between these pressure differences and steep gradients occasionally occur along the range. It is at these times, of course, that winds at Crown Point are strongest, slackening as the gradient lessens, and disappearing almost entirely when the pressure distribution is reversed. However, other important factors contribute to the strength of the gales, principally temperature. Colder weather accompanies high pressure east of the mountains, while to the westward warm weather with southeast or southerly winds may prevail and this temperature gradient is frequently very strong over the mountains, while the pressure gradient may not be unusual. Strong winds are experienced under such conditions. With the movement inland of a low-pressure area in British Columbia a change of the pressure gradient occurs. Often the gradient over the range is reversed in a comparatively short period. At these times, a flow of colder air from the interior obtains and occasionally lasts for several hours before finally being overcome by the more powerful pressure differences. This change was observed frequently during the winter of 1930–31 and on a few occasions caused glaze deposits in the vicinity of the Point when subfreezing temperature prevailed in the easterly winds from the interior while westward and aloft relatively warm weather accompanied by rain was occurring.

The return of the easterly winds was always a slow and gradual process attending the passage of the oceanic high pressure areas inland over the Cascades, and during such times the temperature gradients were unimportant. The wind did not shift to easterly until the center of the high pressure definitely passed over the range, after which the increase in velocity was slow and steady. However, if

a strong continental high had moved southward into the interior, the shift and increase in wind might have been abrupt and accompanied by a cold wave. No such cases occurred during the winter, but during the great wind and dust storm of April 21–24, 1931, a somewhat similar case did occur and the wind at Crown Point rose abruptly from 20 to 50 miles per hour with the arrival of the wind shift. (NOTE.—MONTHLY WEATHER REVIEW, May, 1931, p. 195.)

Conditions of pressure and temperature during the winter 1930–31 were decidedly abnormal, especially as regards the persistence of the plateau high over Idaho and eastern Oregon. During a normal winter such remarkably steady and prolonged gales would not be experienced, but quite likely some higher maximum velocities would occur. An ideal type for winds of hurricane strength would be a strong high moving southward into eastern Washington and Oregon from Canada and an oceanic low-pressure area off the central Oregon coast. Just such a pressure distribution occurred on the night of January 16–17th, 1930, when the destruction of the steel tower, described previously, took place.

Results of the easterly gales in the Columbia River gorge are many and varied but space does not permit their being discussed in detail. In general they are responsible for more uniformly low daytime temperatures at Portland and higher night temperatures during clear, winter weather, while northward and southward away from the effects of the gorge winds much larger ranges in temperature occur. Perhaps one of the most beneficial effects of the gorge winds in the Portland area is their reduction in the hours of ground fog as compared with other sections any distance north or south, where marked temperature inversions occur during clear, calm nights. The motion of the air in the Portland area and its relative dryness are the principal causes for lack of fog. While it must be admitted that the winter of 1930–31 was one of unusual foginess in the valleys between the Cascades and the Coast Range, due to persistence of high pressure over the interior of the Northwestern States and resulting clear skies, the following table has been prepared to show the number of hours during the four month's period, November to February, with moderate or dense fog (visibility three-fourths mile or less):

	Number hours with moderate or dense fog				
	November	December	January	February	Total
Portland.....	96	57	47	29	229
Salem.....	162	180	173	65	580
Roseburg.....	188	135	141	80	544
Seattle.....	185	92	90	42	409

Salem, Roseburg, and Seattle were selected to make the comparison because they are all located in the valley country between the Cascades and Coast Range, although local topography is considerably varied, and because hourly records of fog were available.

During each of the months Portland ranked lowest in the number of hours of fog, the difference being especially marked when compared with the record at Salem (50 miles south of Portland). During December and January, Salem had over three times as many hours with fog as Portland. On no single day during the period did fog persist at Portland throughout the daylight hours, while at Seattle this condition occurred on three days, and at Salem on four days.

In reviewing the record of the easterly gales during the winter of 1930–31 only one phase of the weather in this most unique section has been described.